A.D. 1867, *28th January.* N° 220.

Electric Telegraphs, &c.

LETTERS PATENT to Charles Wheatstone, Gentleman, of Nineteen, Park Crescent, Portland Place, London, County of Middlesex, for the Invention of "IMPROVEMENTS IN ELECTRIC TELEGRAPHS, AND IN APPARATUS CONNECTED THEREWITH."

Sealed the 9th April 1867, and dated the 28th January 1867.

PROVISIONAL SPECIFICATION left by the said Charles Wheatstone at the Office of the Commissioners of Patents, with his Petition, on the 28th January 1867.

I, CHARLES WHEATSTONE, Gentleman, of Nineteen, Park Crescent, Portland Place, London, County of Middlesex, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN ELECTRIC TELEGRAPHS, AND IN APPARATUS CONNECTED THEREWITH," to be as follows:—

My present Invention consists in certain improvements in the various instruments constituting the electric telegraph system described in the Specification of the Patent granted to me on the Second day of June, A.D. 1858, No. 1239.

This system comprises three distinct apparatuses; first, a perforating machine for preparing the messages to be sent on the strips of paper or other suitable material.

Second, a transmitter or apparatus for receiving the strips of paper so prepared, and for transmitting the currents produced by a voltaic battery, magneto-electric machine, or other rheomotor, in the order corresponding to the holes perforated in the strip, the direction and sequence of these currents being governed by pins or other suitable apparatus disposed so as to enter the perforations, and operating in a manner analogous to that in the mechanism of a jacquard loom, and the strip being advanced intermittingly by the action of pins or other apparatus appropriated for that purpose.

And, third, of a recording or printing apparatus adapted to print or impress marks on a strip of paper, such marks corresponding in their arrangement with the currents transmitted to the telegraphic line, and with the apertures in the perforated paper.

I will now proceed to describe the improvements in or relating to these instruments, which improvements form the subject-matter of the present Patent, and I shall class them as belonging to three different systems, according to the ways in which the currents are caused to act in order to produce the effects required.

In the first system, which is that of Patent No. 1239 (A.D. 1858), positive or negative currents or shocks, all of equal length, follow each other in any order; thus two or more currents in the same direction may succeed each other, or positive may be succeeded by negative currents, or vice versa. In this system the alphabet is composed of dots, as in Steinheil's telegraph.

In the second system positive and negative currents are always transmitted in opposite directions, the arrangement being such that the current whether positive or negative produces a mark, of which the length varies according to the time that elapses before the current is reversed, such reversal producing an interval or blank space, the length of which continues to increase until the current in the first direction is renewed. In this system no reacting springs and consequently no adjustments are required in the printing apparatus, as the alternate opposite currents produce the too-and-fro motions of the marker, and lines of various lengths may be printed even when the instantaneous shocks of a magneto-electric machine are employed.

In the third system the currents employed are always in the same direction, but their duration is made to vary, as in the usual Morse's system, and the marks they produce are separated from each other by blank spaces occasioned by intervals of rest or cessation of current. In this system it is necessary to employ a continuously acting rheomotor, such as a voltaic battery, as the currents must have variable durations.

First, Dot Printing System.—My first improvement consists in a modification of the perforator described as the first improvement in the Specification of my Patent, No. 1239 (A.D. 1858). The present improvement provides for the continuity of the middle perforations of the paper strip. The punching plate carries three punches placed transversly to the path of the paper through the machine, as shown in Figure I.; three lever finger keys act upon the punches. Whenever either of the outer keys is depressed it acts upon the punch which belongs to it, and at the same time carries with it the middle punch by means of a collar which is fixed thereto and simultaneously perforates the two apertures, but the depression of the middle key acts upon the middle punch alone and perforates a middle aperture only, which is equivalent to a space in the receiving instrument. On the removal of pressure from any finger key the corresponding punch or punches is or are restored to its or their normal positions by means of a reacting spring or springs; the perforations affected by each finger key are shown at Figure 2. A lever and link arrangement moved by either of the three keys draws back the paper-moving lever during the depression of a key. The release of a key permits a reacting spring to force the paper-moving lever forwards and to advance the paper one step, the said lever having a rough end next to the paper strip for that purpose; this mechanism propels the paper quite independently of the middle row of holes.

My second improvement relates to the magneto-electric transmitter of the dot printing telegraph system. As in the second improvement of No. 1239 (A.D. 1858) the magneto-electric machine and the transmitting gear form a single apparatus moved by the same power. The magneto-electric machine with four fixed coils, which is set forth in the third improvement of N. 2462 (A.D. 1860), is preferred to be used in carrying out the present improvement. On the perforated strip of paper being placed in the groove of the instrument that is provided for its reception, and the handle of the instrument rotated, the said strip is carried onwards through the groove by means of an oscillating pin that enters at each forward movement successively into the holes that compose the middle row of apertures. On each side of the oscillating pin another pin is provided that has a vertical motion; one of these exterior pins is free to enter any perforations that may be presented to it on one side of the middle line of holes, and the other exterior pin is free to enter any perforations that may be presented to it on the other side of the middle row of holes, and by certain mechanism to transmit positive and negative currents to the receiving instrument in accordance with the position, frequency, and sequence of the exterior apertures in the paper strip. The motion of the pins is effected from the driving shaft of the apparatus by an eccentric, connecting rods, crank, rocking shaft, and beam; a rocking piece and certain levers also are employed. One of the connecting rods serves to move the rocking piece in connection with the upper part of the middle pin, the other gives motion to the crank, rocking shaft, and beam, that (by the intervention of levers) produce the vertical motions of the pins; both exterior pins are elevated at the same time by this means so as to be free to enter the perforations (if any present themselves) during the depression and recession of the middle pin. During the recession of the middle pin a spring pin on one extremity of the beam is allowed to nip the paper against the grooved plate of the instrument until the middle pin is again in a position to enter another middle hole and advance the paper again. Spring contacts keep the currents from the machine on short circuit, and only allow currents in one direction to enter the transmitting part of the instrument; contact pieces in connection with the exterior pin levers and with an arm from the beam are so placed as to enable the direction of the currents sent into the telegraphic circuit to be determined by the additional vertical motion that one or other of the exterior pins is allowed to have whenever a perforation of the paper permits it. The direction, frequency, and sequence of the electric currents are thus determined by the joint action of the exterior perforations in the paper strip, and the vertically moving pins of the instrument just described. If the magnets and coils be removed from the magneto-electric transmitter set forth above, and the terminal wires from a voltaic battery be affixed to the binding screws, from which the terminals of the coils of the magneto-electric machine were removed, the apparatus will be converted into a voltaic transmitter. To equalize the motion of the mechanism a fly wheel may be added to the driving shaft of the instrument.

My third improvement consists in a modification of the recording apparatus that forms the third improvement in No. 1239 (A.D. 1858), its object is to act upon the two pens in a suitable manner by means of one set of electro-magnets only, instead of two, thus reducing the electrical resistance to the passage of telegraphic currents through the instruments by one-half. For this purpose a cross piece is mounted upon the upper extremity of the vertical axis that carries two magnetic needles which are free to oscillate between the two poles of a compound electro-magnet, as set forth in the second improvement of No. 1241 (A.D. 1858). The vertical tailed ends of the pen levers respectively rest against adjustable screws in the arms of the cross piece. A positive electric current causes the magnetic needles to incline to one side, and the cross piece to raise the vertical tailed end of one of the pens, and thereby depress its marking end and enable it to make a dot upon the traversing strip of paper, on the cessation of the current a reacting spring (attached to the pen) restores the pen and the cross piece to their respective normal positions. A negative current causes the inclination of the magnetic needles to the other side, and thereby the depression of the marking end of the other pen; on the cessation of the current the pen and the magnetic needles are restored to their respective normal positions by the reacting spring of the pen.

Second, Line Printing System with Alternately Inverted Currents.—My fourth improvement consists in a "perforator" suitable for this system. The punches are five in number, and are arranged in two lines transverse to the length of the paper strip, three punches being in one transverse line and two punches in the othe transverse line. The plan of the punching plate of the instrument is represented in Figure III., the exterior and larger apertures being respectively for the transmission of positive and negative currents, and the middle and smaller apertures for the continuous and regular movement of the paper. By means of a collar attached to the middle punch between the exterior punches, and sliding on the other punches also of certain projections on the punches themselves, the tails of the key levers are made to act so that the left-hand key effects the perforations shown at *a* in Figure IV., the centre key those at *b*, and the right hand key those at *c*. The perforations of the left-hand key occasion dots to be printed at the receiver, those of the centre key spaces, and those of the right-hand key dashes. Reacting springs force the collar and punches back to their normal position upon the release of a finger key; a portion of the tail of each finger key acts upon a lever whenever a key is depressed; the motion of the said lever is conveyed to the paper propellor by means of a connecting rod and oscillating piece or other equivalent mechanism; by this means during the release of a key the paper is advanced the requisite distance, the advance of the paper during the release of the right-hand key being double that which is accomplished by the release of either of the other keys; this double advance at one step is accomplished by allowing the right-hand key lever to have a greater extent of motion, and therefore a greater extent of reaction, than either of the other keys, and by drawing back the blade spring on which one of the stops of the paper propellor is mounted on the release of the right-hand key the paper propellor therefore has double the throw to that afforded by the release of either of the other keys.

My fifth improvement consists of a line printing perforator with more than three finger keys, and by means of which lines of three or more different lengths can be transmitted. In general principle this instrument is the three-keyed perforator with additional keys corresponding to the additional steps that are necessary to transmit the additional lengths of line to the receiving instrument. In a five-keyed instrument there are nine punches, and the punching plate of the instrument presents them to the paper as in

Figure V. The key, which is depressed, determines which of these punches take effect upon the paper, partly in consequence of arrangements exactly analogous to those described in the fourth improvement, and partly in consequence of a vibrating piece which the tails of the last four finger keys support. The first and second keys move through similar arcs, the other keys move through progressively greater arcs according to the number of steps (or lengths of line in the receiver) that they represent; this fact in connection with the previously described points (and since the lengths of the punches vary) enable the five keys to punch the paper as shown at Figure VI. *a* shows the perforation made by the first or left-hand key which determines a space in the receiving strip; *b*, the perforations which determine the shortest line, and *c*, *d*, *e*, those which determine lines of progressively greater lengths. The paper propelling mechanism differs somewhat from that used in the three-keyed perforator, as the propelment of the paper depends entirely upon the central perforations in this (the five-keyed) instrument. The tail of a lever rests upon the tails of all the keys, and is connected (by means of a rod, rack, pinion, click, and ratchet wheel) to a pin wheel in such a manner that the said pin wheel is moved forwards only during the release of a key, and that the extent of its motion exactly accords with the arc of movement of the key; the paper is thereby suitably drawn forward by the pins of the pin wheel. Other equivalent mechanical arrangements may be employed to effect this result.

My sixth improvement consists of a "transmitter" for receiving the strips of paper prepared by either of the "perforators" just described, and transmitting magneto-electric or voltaic currents or shocks along the telegraphic conductor to the receiving instrument at the distant station in accordance with the arrangement of the perforations [illegible] the paper strip. As in the second improvement of No. 1239 (A.D. 1858), the rotation of the handle of the magneto-electric machine also actuates the mechanism that gives motion to the paper strip, and that makes the contacts according to the perforations on the paper, and has also like it a rocking piece with a groove to receive the paper strip, a spring clip which holds the paper firmly during the recession of the rocking piece, and three wires or pins placed transversely to the paper strip, which by entering the external apertures of the paper strip, or by being prevented from entering the paper by the absence of apertures, regulate the succession, frequency, and direction of the electric currents sent into the telegraphic circuit. In the instrument which forms the present improvement the wires or pins act in a different manner from those used in the transmitter described in (No. 1239, A.D. 1858), instead of having a simultaneous vertical motion the two exterior pins are elevated alternately, one being allowed to rock with the middle pin, the other having only a vertical motion. The means of accomplishing this motion is by a suitable arrangement of eccentric and connecting rod gear that actuates a rocking shaft; levers in connection with the rocking shaft communicate motion at the right time to the pins; the action of the pins in conjunction with the paper strip is as follows:—The only means of propulsion of the paper is the motion forwards of the central pin; during the recession of the rocking piece the paper strip stands still; while the rocking piece advances the exterior rocking pin enters an aperture in the paper, or is free to do so if an aperture presents itself; the vertically moving pin acts only during the recession of the rocking piece, and therefore whilst the paper is stationary. This arrangement enables the time during the return or recession of the rocking piece to be used, for during that period the vertically moving pin is free to cause the transmission of an electric current or not, according to whether a perforation of the paper is presented to the said vertical pin or not. As in the transmitter of the first system if the magneto-electric machine be removed, and a voltaic battery be substituted by placing its terminals in connection respectively with the terminals of the wires separated from the coils of the machine, the voltaic transmitter of this system will be constituted.

My seventh improvement relates equally to the receiving instruments of this and of the third system, and consists of an improved method of marking lines by means of ink upon moving strips or bands of paper. In this improvement the printing apparatus consists of a trough of fluid ink, a vertical disc grooved at its circumference which takes the ink from the reservoir and holds it in its groove by capillary attraction, while it is kept in motion by the maintaining power, and of a smaller disc, called the "tracer" or marker, which, touching the ink retained in the groove without coming in contact with the larger disc itself is also kept in motion immediately by the maintaining power. The marking or tracing disc is so mounted that its axis while rotating is capable of being moved by the action of the electro-magnets so as to bring the disc in contact with the paper. In the receiving instrument of this system a current in one direction causes the marking disc to move towards the paper and trace the line, and the current in the opposite direction removes the disc to form the intervals, the residual magnetism of the electro-magnet retaining the magnetic armature, and consequently the tracing disc in its position until a contrary current inverts the magnetism, and causes the armature to move to the opposite side and the tracing disc to recede from the paper. In the receiving instrument of the third system when the currents, which are always in the same direction, act they move the tracer towards the paper, and the reaction of the armature spring occasioned by the cessation of the currents removes the tracing disc to its normal position. In this form of the receiving instrument magneto-electric currents cannot be employed, as the currents are required to be of variable duration.

Third, System in which the Currents are Transmitted in One Direction only.—My eighth improvement consists of an automatic transmitter which is adapted to act upon the usual Morse's receiver, or any modification of it in which the marks on the paper are produced by currents in one direction only, and the intervals by the removal of the marker from the paper by means of a reacting spring brought into action by the cessation of the current. In this modification of the transmitter the driving wheel, fly wheel, eccentric, rocking piece, beam, and vertical needles are the same as set forth in the sixth improvement.. As in the line printer with inverted currents the number of middle perforations or steps in the transmitting slip determines the length of line which is marked by the receiving instrument on the receiving strip. The line wire is connected with the insulated frame of the instrument; one pole of the battery (the other being connected with the earth) terminates in an adjustable stud fitted in an insulated piece, and a similar stud insulated in like manner is connected immediately with the earth. Between these two studs which are placed near to and opposite each other an oscillating arm carried on an axis which carries also two other arms equidistant from the first moves too and fro so as to touch either stud. This too-and-fro motion is occasioned by the alternate elevation and depression of the two outer needles when the instrument is set in action, and no strip of perforated paper is passed through; each of these needles is connected by means of a crank with a lever, which when the needle is depressed acts upon one of the lever arms, and presses the contact arm against either the battery or earth stud, according as the one needle or the other is depressed. A blade spring with a catch at its free end rests against the end of the contact arm, and keeps it in contact either with the battery or earth stud until a motion in the opposite direction carries it to the opposite contact, where it is similarly retained. When the strip of paper is inserted the absence of an aperture keeps the needle depressed, and does not release the contact occasioned previously by the depression of the other needle, which may therefore be kept on for any length of time. The perforators set forth as the fourth and fifth improvements are equally adapted to prepare the strips of paper for a transmitter of this construction. The automatic transmitters herein-before described are also suited for acting upon distant telegraphic receiving instruments in which the signals are not permanently recorded; but in such cases it will be only greater regularity and correctness that will be insured, as the speed must be limited by the capability of reading the transmitted signals. On the other hand, the printing or marking receiving instruments herein-before described are not necessarily to be used in conjunction with the automatic transmitters, excepting where great speed is required. Keys directing the currents from a voltaic battery, or a magneto-electric machine to be worked by the hands of an operator and constructed on principles commonly known, may be employed to bring them into action.

Having separately described each system of recording telegraphs, with the improvements which form the objects of the present Specification, I proceed to designate those points which I specially claim as new.

First, the modification of the perforator for the dot printing telegraph which enables it to prepare the strips of paper with an uninterrupted series of central apertures; this modification, described as the first improvement, consists of the mechanism being so arranged that when either of the keys corresponding with the outer apertures is depressed, besides acting on its own punch it carries with it the punch which corresponds with the central apertures, while the latter is alone acted upon by means of another key causing the perforation only of a single aperture at a time.

Second, the modification of the perforator, described as the fourth improvement, having five punches, and the mechanism so arranged that when the first key is pressed three of the punches in the order described are simultaneously acted upon; when a second key is depressed four of the punches are in like manner simultaneously acted upon, and when a third key is depressed the single punch only of the central line is acted upon. I claim also, in connection with this arrangement, the mechanism by which when either the first or third keys are pressed down the paper advances only a single space, and when the second key is depressed it advances two spaces; but be it understood that I do not claim the advance of the paper by unequal spaces unless in connection with the arrangement of the punches described.

Third, the additions of extra keys to the preceding modification of the perforator with additional punches, described in the fifth improvement, which are so arranged that each additional key when depressed, while it punches simultaneously all the required apertures, shall advance the paper at once three, four, or more steps, so that all the perforations may be simultaneously made which are necessary to cause lines of the various required lengths to be marked or printed by the receiving instrument.

Fourth, the modification of the transmitter, described as the second improvement, whether actuated by a magneto-electric machine or by a voltaic battery, in which the central needle alone has a too-and-fro motion for the purpose of propelling forward the strip of paper by means of the central apertures alone, and not also by means of the external apertures and outer pins, as described in the second improvement of the Specification of my Patent, No. 1239 (A.D. 1858).

Fifth, the modification of the transmitter, described as the sixth improvement, which is adapted to send into the telegraphic circuit short currents at various intervals and alternately in opposite directions, so as to determine the occurrence of printed lines and intervals of various lengths in the receiving instrument; in this modification one current governing needle has a too-and-fro motion simultaneously with the central needle, while the other has no such motion, the latter acting only while the paper is at rest, and the former while it is in motion.

Sixth, the modification of the transmitter, described as the eighth improvement, which is suited to send into the telegraphic circuit currents of various lengths in one direction only in a different way to that described as the seventh improvement in my Patent No. 2462 (A.D. 1860). The characteristics of this new method are, first, that lines of any lengths can be produced instead of lines of two different lengths only; second, that the short lines occupy a shorter space on the paper than the long lines do; and, third, that strips of paper prepared by the perforators of the third and fourth improvements may be employed to regulate the motions of the needles in order to produce the required effects.

Seventh, the modification of the dot printing receiving instrument, described as the third improvement, in which the pens or markers are acted upon by one set of electro-magnets and magnetic bars instead of by two sets, as described in the Specification of my Patent No. 1239 (A.D. 1858).

Eighth, that modification of the printing apparatus of the receiving instruments of the second and third systems, described as the eighth improvement, by means of which lines of various lengths are printed with great rapidity, certainty, and distinctness. The characteristic distinction of this mode of printing is, that the inking disc and tracing disc are both independently kept in motion by the maintaining power and are not in actual contact with each other, and that the ink is retained on the circumference of the inking disc by capillary attraction.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Charles Wheatstone in the Great Seal Patent Office on the 24th July 1867.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, CHARLES WHEATSTONE, of Nineteen, Park Crescent, Portland Place, London, County of Middlesex, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twenty-eighth day of January, in the year of our Lord One thousand eight hundred and sixty-seven, in the thirtieth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Charles Wheatstone, Her special licence that I, the said Charles Wheatstone, my executors, administrators, and assigns, or such others as I, the said Charles Wheatstone, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN ELECTRIC TELEGRAPHS, AND IN APPARATUS CONNECTED THEREWITH," upon the condition (amongst others) that I, the said Charles Wheatstone, my executors or administrators, by an instrument in writing under , or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Charles Wheatstone, do hereby declare the nature of the said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

My present Invention consists in certain improvements in the various instruments constituting the electric telegraph system described in the Specification of the Patent granted to me on the Second day of June, A.D. 1858, No. 1239.

This system comprised three distinct apparatuses; first, a perforating machine for preparing the messages to be sent on strips of paper or other suitable materials.

Second, a transmitter or apparatus for receiving the strips of paper so prepared, and for transmitting the currents produced by a voltaic battery, magneto-electric machine, or other rheomotor in the order corresponding to the holes perforated in the strip, the direction and sequence of these currents being governed by pins or other suitable apparatus disposed so as to enter the perforations and operating in a manner analogous to that in the mechanism of a jacquard loom, and the strip being advanced intermittingly by the action of pins or other apparatus appropriated for that purpose.

And third, of a recording or printing apparatus adapted to print or impress marks on a strip of paper, such marks corresponding in their arrangement with the currents transmitted to the telegraphic line, and with the apertures in the perforated paper.

I will now proceed to describe the improvements in or relating to these instruments, which improvements form the subject matter of the present Patent, and I shall class them as belonging to three different systems according to the ways in which the currents are caused to act in order to produce the effects required.

In the first system, which is that of Patent No. 1239, A.D. 1858, positive or negative currents or shocks all of equal length follow each other in any order; thus two or more currents in the same direction may succeed each other, or positive may be succeeded by negative currents, or vice versa. In this system the alphabet is composed of dots as in Steinheil's telegraph.

In the second system positive and negative currents are always transmitted alternately in opposite directions, the arrangement being such that the current, whether positive or negative produces a mark of which the length varies according to the time that elapses before the current is reversed, such reversal producing an interval or blank space, the length of which continues to increase until the current in the first direction is renewed. In this system no reacting springs, and consequently no adjustments are required in the printing apparatus as the alternate opposite currents produce the to-and-fro motions of the marker; and lines of various lengths may be printed even when the instantaneous shocks of a magneto-electric machine are employed.

In the third system the currents employed to produce the marks are always in the same direction, but their duration is made to vary as in the usual Morse's system, and the marks are separated from each other by blank spaces occasioned by intervals of rest or cessations of current. In this system it is necessary to employ a continuously acting rheomotor, such as a voltaic battery, as the currents must have variable durations.

First, Dot Printing System.—My first improvement consists in a modification of the perforator, described as the first improvement in the Specification of my Patent, No. 1239, A.D. 1858.

The present improvement provides for the continuity of the middle perforations of the paper strip. The punching plate carries three punches placed transversely to the path of the paper through the machine, as shown in Figure 1. Three lever finger keys act upon the punches in such a manner that whenever either of the outer keys is depressed it acts upon the punch which belongs to it, and at the same time carries with it the middle punch by means of a collar which is fixed thereto, and simultaneously perforates the two apertures, but the depression of the middle key acts upon the middle punch alone and perforates a middle aperture only, which is equivalent to a space in the receiving instrument. On the removal of pressure from any finger key the corresponding punch or punches is or are restored to its or their normal positions by means of a reacting spring or springs. The perforations effected by each finger key are shown at Figure 2. A lever and link arrangement moved by either of the three keys draws back the paper moving lever during the depression of a key; the release of a key permits a reacting spring to force the paper moving lever forwards, and to advance the paper one step, the said lever having a rough end next to the paper strip for that purpose; this mechanism propels the paper quite independently of the middle row of holes. The essential details of the dot printing perforator are described and figured as the line printing perforator, Figures 12, 13, 14, 15.

My second improvement relates to the magneto-electric transmitter of the dot printing telegraph system.

As in the second improvement of No. 1239, A.D. 1858, the magneto-electric machine, and the transmitting gear form a single apparatus moved by the same power. The magneto-electric machine with four fixed coils, which is set forth in the third improvement of No. 2462, A.D. 1860, is preferred to be used in carrying out the present improvement. On the perforated strip of paper being placed in the groove of the instrument that is provided for its reception, and the handle of the instrument rotated, the said strip is carried onwards through the groove Q, Figure 7, by means of an oscillating pin *y* that enters at each forward movement successively into the holes that compose the middle row of apertures. On each side of the oscillating pin another pin *x* and *z* is provided that has a vertical motion; one of these exterior pins is free to enter any perforations that may be presented to it on one side of the middle line of holes, and the other exterior pin is free to enter any perforations that may be presented to it on the other side of the middle row of holes, and by certain mechanism to transmit positive and negative currents to the receiving instrument in accordance with the position, frequency, and sequence of the exterior apertures in the paper strip. The motion of the pins is effected from the driving shaft G, Figure 7, of the apparatus by an eccentric, connecting rods, crank, rocking shaft, and beam; a rocking piece M^1 and certain levers also are employed. One of the connecting rods serves to move the rocking piece in connection with the upper part of the middle pin, the other gives motion to the crank, rocking shaft M, and beam W, Figures 8, 9, that (by the intervention of levers) produce the vertical motions of the pins. The rocking frame M, Figures 7, 8, attached to the axis *o*, o^1, terminates in the cross piece M, through which the extremity of the centre pin *y* passes, so that by the oscillations of the frame M, consequent on the revolution of suitable gearing, the extremity of the central pin *y* will be caused to rock and enter the central perforations of a strip of prepared paper placed in the groove Q between the frame plates *c*, *d*, thus causing the paper to be drawn forward a certain space at every oscillation. Both exterior pins *x*, *z*, respectively attached to levers at *a* and *l*, whose fulcrums are at *b* and *m*, are therefore elevated at the same time; reacting springs shown at *n*, *e*, Figure 9, tend to press these levers upwards so as to follow the movements of the arm W^1, unless one or both the pins are prevented from rising by the absence of perforations in the paper strip corresponding to their external position. During the recession of the middle pin *y* a spring pin on one extremity of the beam W is allowed to nip the paper against the grooved plate *d* of the instrument until the middle pin is again in a position to enter another middle aperture, and advance the paper again. Spring contacts are so arranged as to cut off all currents from the machine on short circuit, and only allow currents in one direction to enter the transmitting part of the instrument. Contact pieces in connection with the exterior pin levers *x* and *z*, and with the arm W^1 from the beam W, are so placed as to enable the direction of the currents sent into the telegraphic circuit to be determined by the additional vertical motion that one or other of the exterior pins *x* and *z* is allowed to have whenever a perforation of the paper permits it. The direction, frequency, and sequence of the electric currents are thus determined by the joint action of the exterior perforations in the paper strip and the vertically moving pins *x* and *z* of the instrument just described. If the magnets and coils be removed from the magneto-electric transmitter set forth above, and the terminal wires from a voltaic battery be affixed to the binding screws from which the terminals of the coils of the magneto-electric machine were removed, the apparatus will be converted into a voltaic transmitter. To equalise the motion of the mechanism a fly wheel may be added to the driving shaft of the instrument.

My third improvement consists in a modification of the recording apparatus that forms the third improvement in No. 1239, A.D. 1858; its object is to act upon the two pens in a suitable manner by means of one set of electromagnets only instead of two, thus reducing the electrical resistance to the passage of telegraphic currents through the instrument by one-half. For this purpose a cross piece F, Figure 10, is mounted upon the upper extremity of the vertical axis A that carries two magnetic needles B, C, which are free to oscillate between the two poles of a compound electro-magnet E, as set forth in the second improvement of No 1241, A.D. 1858. The vertical tailed ends *d* of the pen levers *y*, *z*, centred at N, respectively rest against adjustable screws *e*, *f*, in the arms *a*, *b*, of the cross piece F, shown in plan, Figure 11. A positive electric current causes the magnetic needles B, C, to incline to one side, and the cross piece F to raise the vertical tailed end *d* of one of the pens *y*, *z*, and thereby depress its marking end into the reservoir of ink I, and enable it to make a dot upon the traversing strip of paper; on the cessation of the current a reacting spring (attached to the pen) restores the pen and the cross piece to their respective normal positions. A negative current causes the inclination of the magnetic needles to the other side, and thereby the depression of the marking end of the other pen; on the cessation of the current the pen and the magnetic needles are restored to their respective normal positions by the reacting spring of the pen.

Second, Line Printing System with Alternately Inverted Currents.—My fourth improvement consists in a "perforator" suitable for this system. The punches are five in number, and are arranged in two lines, three punches being in one transverse line, and two punches in the other transverse line. The plan of the punching plate of the instrument is represented in Figure 13, the exterior and larger apertures being respectively for the transmission of positive and negative currents, and the middle and smaller apertures for the continuous and regular movement of the paper; this strip of paper with suitable perforations on being passed through my transmitter to be presently described will effect at the receiving instrument the printing of the dots and dashes of the Morse alphabet. A, C, B, Figure 12, are three finger keys, the touches arranged in the same transverse line C being employed to effect the centre perforations, and for this purpose the lever on which the touch rests is bent so as to pass under lever A; these three lever keys are each free to move about the axis D.

The punches *a*, *b*, *c*, *d*, *e*, Figure 13, are five in number arranged horizontally in two parallel vertical planes, the one containing three punches *c*, *d*, *e*, the other two punches *a*, *b*; the punches are supported by the guiding pieces Q, R, shown in Figure 15. The whole of the punches pass through the collar piece E, to which the central punch *d* is attached; this collar piece E slides on two horizontal bars or guide rods F, G, around which are wound helical springs tending to maintain the collar in its normal position; the ends of the punches at the back of the collar E are enlarged so that they cannot pass through the apertures in the collar, and hence, if any, one or more of the punches *a*, *b*, *c*, *d*, *e*, are pressed forward, by the action of the lever keys A, C, B, the collar E will advance, carrying with it the centre punch *d*, and on the release of the finger key the helical springs will force the collar back to its normal position, and with it any of the punches which may have been pressed forward; the ends of the punches *c*, *d*, *e*, rest against the end of the lever key A, which owing to the bending outwards of the said lever key is placed in the centre; vertical pressure on the touch A will therefore cause punches *c*, *d*, *e*, to advance and perforate the paper, passing through the groove Q with three holes in the same transverse line. To the collar E is attached a short rod resting against the end of lever key C, so that this lever key being depressed the collar will be forced forward, carrying with it the punch *d*, and so effect the perforation of the centre hole only in the paper. Lastly, a short rod attached to the punch *c*, which with the ends of the punches *a*, *b*, rest against the end of the lever key B, causes, upon the depression of the touch B, the simultaneous advance of the four punches *a*, *b*, *c*, *d*, (the collar E carrying *d* with it), and hence the perforation of the paper with two centre and two outer holes; thus the left-hand key A effects the perforations shown at *a* in Figure 4, the centre key C those at *b*, and the right-hand key B those at *c*. The perforations of the left-hand key A occasions dots to be printed at the receiver, those of the centre key C spaces, and those of the right-hand key B dashes. A portion of the tail of each finger key acts upon a lever whenever a key is depressed; the motion of the said lever is conveyed to the paper propellor by means of a connecting rod and oscillating piece or other equivalent mechanism; by this means during the release of a key the paper is advanced the requisite distance, the advance of the paper during the release of the right-hand key B being double that which is accomplished by the release of either of the other keys A, C; this double advance at one step is accomplished by allowing the right-hand key lever to have a greater extent of motion, and therefore a greater extent of reaction than either of the other keys, and by drawing back the blade spring, on which one of the stops of the paper propellor is mounted, on the release of the right-hand key the paper propeller therefore has double the throw to that afforded by the release of either of the other keys.

My fifth improvement consists of a line printing perforator with more than three finger keys, and by means of which lines of three or more different lengths can be transmitted. In general principle this instrument is the three-keyed perforator with additional keys corresponding to the additional steps that are necessary to transmit the additional lengths of line to the receiving instrument. In a five-keyed instrument there are nine punches, and the punching plate of the instrument presents them to the paper, as shown in Figure 5. The key which is depressed determines which of these punches takes effect upon the paper, partly in consequence of arrangements exactly analogous to those described in the fourth improvement, and partly in consequence of a vibrating piece which the tails of the last four finger keys support. The first and second keys move through similar arcs, the other keys move through progressively greater arcs according to the number of steps or lengths of line in the receiver that they represent; this fact in connection with the previously described points (and since the lengths of the punches vary) enable the five keys to punch the paper, as shown at Figure 6. *a* shows the perforation made by the first or left-hand key which determines a space in the receiving strip; *b*, the perforations which determine the shortest line; and *c*, *d*, *e*, those which determine lines of progressively greater lengths. The paper propelling mechanism differs somewhat from that used in the three-keyed perforator, as the propelment of the paper depends entirely upon the central perforations in this (the five-keyed) instrument. The tail of a lever R, Figure 16, rests upon the tails of all the keys, and is connected by means of a rod U, rack V^1, pinion V, click W, and ratchet wheel X to a pin wheel Y, in such a manner that the said pin wheel is moved forwards only during the release of a key, and that the extent of its motion exactly accords with the arc of movement of the key; the paper is thereby suitably drawn forward by the pins of the pin wheel. Other equivalent mechanical arrangements may be employed to effect this result.

My sixth improvement consists of a "transmitter" for receiving the strips of paper prepared by either of the "perforators" just described, and transmitting magneto-electric or voltaic currents or shocks along the telegraphic conductor to the receiving instrument at the distant station in accordance with the arrangement of the perforations in the paper strip. As in the second improvement of No. 1239, A.D. 1858, the rotation of the handle of the magneto-electric machine also actuates the mechanism that gives motion to the paper strip, and that makes the contacts according to the perforations on the paper, and has also like it a rocking piece with a groove to receive the paper strip; a spring clip which holds the paper firmly during the recession of the rocking piece, and three wires or pins placed transversely to the paper strip which by entering the external apertures thereof, or by being prevented from entering the paper by the absence of apertures, regulate the succession, frequency, and direction of the electric currents sent into the telegraphic circuit.

In the instrument which forms the present improvement the wires or pens act in a different manner from those used in the transmitter described in No. 1239, A.D. 1858; instead of having a simultaneous vertical motion the two exterior pins are elevated alternately, one being allowed to rock with the middle pin, the other having only a vertical motion. The means of accomplishing this motion is by a suitable arrangement of eccentric and connecting rod gear that actuates a rocking shaft. Levers in connection with the rocking shaft communicate motion at the right time to the pins.

The action of the pins in conjunction with the paper strip is as follows:— The only means of propulsion of the paper is the motion forwards of the central pin. During the recession of the rocking piece the paper strip stands still. While the rocking piece advances the exterior rocking pin enters an aperture in the paper, or is free to do so if an aperture presents itself. The vertically moving pin acts only during the recession of the rocking piece, and therefore whilst the paper is stationary this arrangement enables the time during the return or recession of the rocking piece to be used, for during that period the vertically moving pin is free to cause the transmission of an electric current or not according to whether a perforation of the paper is presented to the said vertical pin or not. As in the transmitter of the first system, if the magneto-electric machine be removed and a voltaic battery be substituted by placing its terminals in connection respectively with the terminals of the wires separated from the coils of the machine the voltaic transmitter of this system will be constituted. In order to insure the due retention of the paper each time the rocking frame recedes, and yet allow the cross sections of the heads of the vertical pins *x*, *y*, *z*, Figure 19, to be of smaller diameter than the perforations in the paper so that slight irregularities and imperfections in the punching of the perforations may not affect the due working of the apparatus I introduce a fourth vertical needle or rod solely to nip the paper, and for this purpose whilst obtaining the same results as before modify the arrangements of the parts. The driving wheel B, Figure 17, gears with the pinion F, on the axis *f* of which is mounted the double eccentric I with horizontal and vertical arms R, K; the end of the arm R is connected by the rod L to the rocking frame M, pivoted at o, o^1, the head of which as before enters the transverse aperture in the groove Q, Figure 19. The vertical arm K of the eccentric I is attached to end *s* of the horizontal beam S, the other end of which carries the rod W, the head of which enters through the lower plate *c* into the groove Q. Whenever the end of the vibrating beam S is elevated the rod W presses against the upper plate *d*, nipping the paper and retaining it whilst the rocking frame M recedes and releasing the paper as the rocking frame advances. The rod W is made of two parts so that by means of the helical spring *w* the pressure against the paper may yield and adjust itself. At *b* on the beam S is centered the lever T, carrying at its extremity the centre vertical pin *y*, the head of which enters the apertures in the rocking frame M. At opposite sides of the insulating ebonite slab *q* are mounted on fulcrums *g*, *h*, the two levers *a*, *l*, carrying at their extremities the vertical pins *x*, *z*, the head of the pin *x* enters an aperture in the plates *c*, *d*, while the head of the pin *z* enters the head of the rocking frame M. The reacting springs *n*, *e*, tend to keep the heads of the vertical pins *x*, *z*, pressing upwards. The beam S also carries a connecting rod X attached to one end of the ebonite beam Y working on the centre z^1, the other end of this ebonite beam carries a contact stud *i* connected with one pole of the battery or other source of electric power. By the movement of the beam Y this contact pin is caused to oscillate between the two springs *o* and *p* respectively attached to the spiral spring *e* in connection with the line wire and with the earth wire, while a fixed stud i^1 between the two springs *o* and *p* is connected with the other pole of the battery, one of the springs will therefore rest upon this stud whenever the other is pressed away by the movement of the contact stud *i*. By this arrangement if a strip of perforated paper be inserted in the groove Q, upon giving motion to the machine the action of the double eccentric I will effect the oscillation of the rocking frame M, and cause the central pin *y* to enter the central perforations in the paper and carry it with it during the advancement of the rocking frame M, at the same time the rod W will nip the paper upon the withdrawal of the pin *y* and recession of the rocking frame. The outside perforations in the paper will determine the rise of the vertical pins *x* and *z*, and by this means the inversion and order of the succession of alternate currents flowing into the line wire.

The action of the pins *x*, *y*, *z*, in conjunction with the paper strip is as follows:—The only means of propulsion of the paper is the motion forwards of the central pin *y*; during the recession of the rocking frame M the paper strip stands still. While the rocking frame advances the exterior rocking pin *z* enters an aperture in the paper, or is free to do so if an aperture presents itself; the vertically moving pin *x* acts only during the recession of the rocking piece, and therefore whilst the paper is stationary. This arrangement enables the time during the return or recession of the rocking piece to be used, for during that period the vertically moving pin x is free to cause the transmission of an electric current or not, according to whether a perforation of the paper is presented to the said vertical pin or not. As in the transmitter of the first system, if the magneto-electric machine be removed, and a voltaic battery be substituted by placing its terminals in connection respectively with the terminals of the wires separated from the coils of the machine, the voltaic transmitter of this system will be constituted.

My seventh improvement relates equally to the receiving instruments of this and of the third system, and consists of an improved method of marking lines by means of ink upon moving strips or bands of paper.

In this improvement the printing apparatus consists of a trough of fluid ink, a vertical disc grooved at its circumference, which takes the ink from the reservoir and holds it in its groove by capillary attraction, while it is kept in motion by the maintaining power, and of a smaller disc called the tracer or marker, which touching the ink retained in the groove without coming in contact with the larger disc itself is also kept in motion immediately by the maintaining power. The marking or tracing disc is so mounted that its axis while rotating is capable of being moved by the action of the electro-magnets, so as to bring the disc in contact with the paper. In the receiving instrument of this system a current in one direction causes the marking disc to move towards the paper and trace the line, and the current in the opposite direction removes the disc to form the intervals, the residual magnetism of the electro-magnet retaining the magnetic armature and consequently the tracing disc in its position until a contrary current inverts the magnetism, and causes the armature to move to the opposite side, and the tracing disc to recede from the paper. In the receiving instrument of the third system when the currents which are always in the same direction act, they move the tracer towards the paper, and the reaction of the armature spring, occasioned by the cessation of the currents, removes the tracing disc to its normal position. In this form of the receiving instrument magneto-electric currents cannot be employed, as the currents are required to be of variable duration. The magnetic armatures A, Figure 21, are placed in a vertical position; the central axis B is prolonged so as to carry the cross piece C, through an aperture in the extremity of which a horizontal rod D passes, on which is mounted at one extremity the small light tracing disc E, whilst the opposite end, which is loosely centered so as to be capable of a slight lateral movement, carries a small toothed wheel F; this wheel gearing with the maintaining power of the instrument imparts a rotatory motion to the tracer E, at the same time that the axis D is capable of receiving a to-and-fro motion in a horizontal plane from the movement of the armatures A and arm C. In the same vertical plane and immediately beneath the tracing disc is an inking disc G, Figures 21 and 22, of any suitable size, also caused to rotate by appropriate gearing with the maintaining power of the apparatus; this disc revolves in a reservoir H containing ink or other suitable marking fluid. The periphery of the disc G is slightly hollowed, and the edge of the tracing disc E justs enters this hollow without contact or friction with the inking disc; during the revolution of the disc G capillary attraction keeps the hollow full of ink, and a constant and uniform quantity will be supplied to the tracing disc. The paper intended to receive the marks is drawn forward at suitable speed over a roller M in close proximity to one edge of the tracing disc. From this arrangement it will be understood that a series of instantaneous alternate currents passing through the electro-magnets will cause a to-and-fro motion of the tracing disc E, a current in one direction pressing the tracing disc against the paper, where it will remain by reason of the residual magnetism of the electro-magnets retaining the armatures A in that position until a current in the opposite direction withdraws the tracer from the paper. By this arrangement lines of more than two lengths can be printed with perfect accuracy in connection with the perforator described as the fifth improvement.

Third System, in which the Currents are Transmitted in One Direction only.—My eighth improvement consists of an automatic transmitter which is adapted to act upon the usual Morse's receiver or any modification of it, in which the marks on the paper are produced by currents in one direction only, and the intervals by the removal of the marker from the paper, by means of a reacting spring brought into action by the cessation of the current. In this modification of the transmitter the driving wheel, fly wheel, eccentric, rocking frame, beam, and vertical needles are the same as set forth in the sixth improvement. As in the line printer with inverted currents the number of middle perforations or steps in the transmitting slip determines the length of line which is marked by the receiving instrument on the receiving strip. The line wire is connected with the insulated frame of the instrument, Figure 20, one pole of the battery (the other being connected with the earth) terminates in an adjustable stud *j* fitted in an insulated piece *q*, and a similar stud *k* insulated in like manner is connected immediately with the earth. Between these two studs, which are placed near to and opposite each other, an oscillating arm X carried on an axis x^1, which carries also two other arms i, i^1, equidistant from the first, moves to and fro so as to touch either of the studs j, k; this to-and-fro motion is occasioned by the alternate elevation and depression of the two outer needles x, z, when the instrument is set in action, and as the strip of perforated paper is passed through; each of these needles is connected by means of a crank with a lever a, l, which when the needle is depressed acts upon one of the lever arms i, i^1, and presses the contact arm against either the battery or earth stud j, k, according as the one needle or the other is depressed; a blade spring m with a catch m^1 at its free end rests against the end of the contact arm X, and keeps it in contact either with the battery or earth stud j, k, until a motion in the opposite direction carries it to the opposite contact, where it is similarly retained. When the strip of paper is inserted the absence of an aperture keeps the needle depressed and does not release the contact occasioned previously by the depression of the other needle which may therefore be kept on for any length of time.

The perforators set forth as the fourth and fifth improvements are equally adapted to prepare the strips of paper for a transmitter of this construction. It will therefore be understood that on a perforation coming over the needle z the triangular piece X will cause it to make contact for line and battery, and this contact will continue until a perforation on the opposite side of the paper comes over the needle x, when the triangular piece X will be withdrawn from contact screw k to contact screw j, thereby putting the line wire to earth hence the interval between the perforations on opposite sides of the paper will determine the length of the mark produced by the receiving instrument at the distant station, and by the use of slips of paper perforated as described with reference to the fifth improvement four different lengths of line could be automatically transmitted with perfect accuracy, and if desired this number might be increased, and the Morse alphabet thereby proportionately shortened.

The automatic transmitters herein-before described are also suited for acting upon distant telegraphic receiving instruments in which the signals are not permanently recorded, but in such cases it will be only greater regularity and correctness that will be ensured, as the speed must be limited by the capability of reading the transmitted signals. On the other hand the printing or marking receiving instruments herein-before described are not necessarily to be used in conjunction with the automatic transmitters, excepting where great speed is required. Keys directing the currents from a voltaic battery or a magneto-electric machine to be worked by the hands of an operator, and constructed on principles commonly known, may be employed to bring them into action.

The various transmitters as represented and described in this Specification are intended to be worked by hand, but when required a train of wheels actuated by a weight or spring and provided with a means of regulating the speed may be applied to either of them.

The printing apparatus may also be provided with a means of regulating the speed so that it may be worked either rapidly with an automatic transmitter, or slowly with finger keys. But as these objects may be effected in various known ways, and as they form no indispensable part of my Invention further description would be unnecessary.

Having separately described each system of recording telegraphs with the improvements which form the objects of the present Specification, I proceed to designate those points which I specially claim as new,—.

First, the modification of the perforator for the dot printing telegraph which enables it to prepare the strips of paper with an uninterrupted series of central apertures. This modification, described as the first improvement, consists of the mechanism being so arranged that when either of the keys corresponding with the outer apertures is depressed, besides acting on its own punch it carries with it the punch which corresponds with the central apertures, while the latter is alone acted upon by means of another key causing the perforation only of a single aperture at a time.

Second, the modification of the perforator described as the fourth improvement, having five punches, and the mechanism so arranged that when the first key is pressed three of the punches in the order described are simultaneously acted upon; when a second key is depressed four of the punches are in like manner simultaneously acted upon; and when a third key is depressed the single punch only of the central line is act upon.

I claim also in connection with this arrangement the mechanism by which when either the first or third keys are pressed down the paper advances only a single space, and when the second key is depressed it advances two spaces; but be it understood that I do not claim the advance of the paper by unequal spaces unless in connection with the arrangement of the punches described.

Third, the addition of extra keys to the preceding modification of the perforator with additional punches, described in the fifth improvement, which are so arranged that each additional key when depressed, while it punches simultaneously all the required apertures, shall advance the paper at once three, four, or more steps, so that all the perforations may be simultaneously made which are necessary to cause lines of the various required lengths to be marked or printed by the receiving instrument.

Fourth, the modification of the transmitter, described as the second improvement, whether actuated by a magneto-electric machine or by a voltaic battery, in which the central needle alone has a to-and-fro motion for the purpose of propelling forward the strip of paper by means of the central apertures alone, and not also by means of the external apertures and outer pins, as described in the second improvement of the Specification of my Patent, No. 1239, A.D. 1858.

Fifth, the modification of the transmitter, described as the sixth improvement, which is adapted to send into the telegraphic circuit short currents at various intervals and alternately in opposite directions, so as to determine the occurence of printed lines and intervals of various lengths in the receiving instrument. In this modification one current governing needle has a to-and-fro motion simultaneously with the central needle, while the other has no such motion, the latter acting only while the paper is at rest, and the former while it is in motion.

Sixth, the modification of the transmitter, described as the eighth improvement, which is suited to send into the telegraphic circuit currents of various lengths in one direction only, in a different way to that described as the seventh improvement in my Patent No. 2462, A.D. 1860.

The characteristics of this new method are, first, that lines of any lengths can be produced instead of lines of two different lengths only; second, that the short lines occupy a shorter space on the paper than the long lines do; and, third, that strips of paper prepared by the perforators of the third and fourth improvements may be employed to regulate the motions of the needles in order to produce the required effects.

Seventh, the modification of the dot printing receiving instrument, described as the third improvement, in which the pens or markers are acted upon by one set of electro-magnets and magnetic bars, instead of by two sets, as described in the Specifications of my Patent, No. 1239, A.D. 1858.

Eighth, that modification of the printing apparatus of the receiving instruments of the second and third systems, described as the eighth improvement, by means of which lines of various lengths are printed with great rapidity, certainty, and distinctness.

The characteristic distinction of this mode of printing is, that the inking disc and tracing disc are both independently kept in action by the maintaining power, and are not in actual contact with each other, and that the ink is retained on the circumference of the inking disc by capillary attraction.

In witness whereof, I, the said Charles Wheatstone, have hereunto set my hand and seal, this Twenty-fourth day of July, in the year of our Lord One thousand eight hundred and sixty-seven.

CHARLES WHEATSTONE. (L.S.)

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1867.

A.D. 1867. JAN. 28. Nº 220.
WHEATSTONE'S PROVISIONAL SPECIFICATION.

(1 SHEET)

FIG. I.

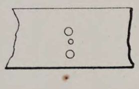


FIG. II.

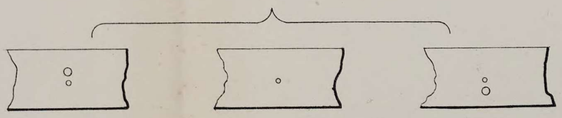


FIG. III.

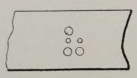
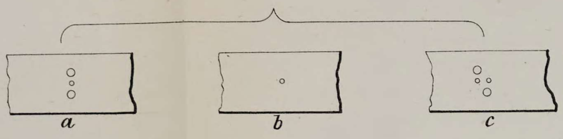


FIG. 4.



a b c

FIG. 5.

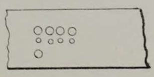
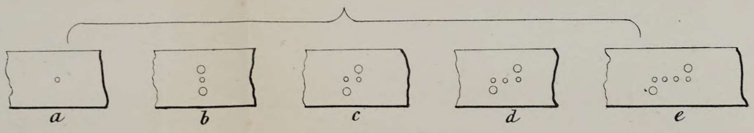


FIG. 6.



a b c d e

The drawing left with Provisional Specification is not colored.

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Printers to the Queen's most Excellent Majesty. 1867

A.D. 1867. JAN. 28. Nº 220.
WHEATSTONE'S SPECIFICATION.

(1 SHEET)

FIG. 1.

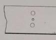


FIG. 2.

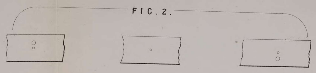


FIG. 3.

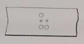
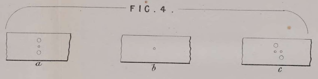


FIG. 4.



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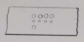

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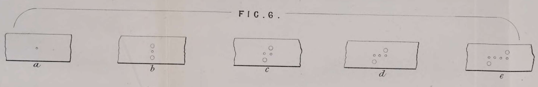

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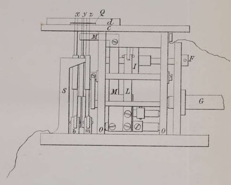

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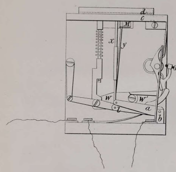

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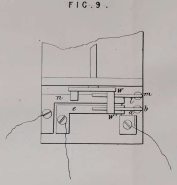

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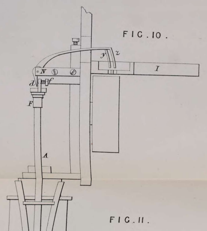

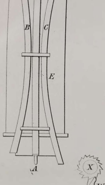

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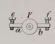

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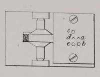

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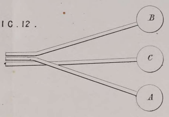

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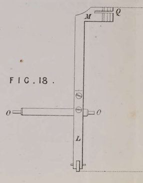

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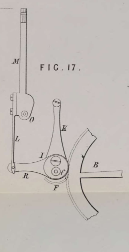

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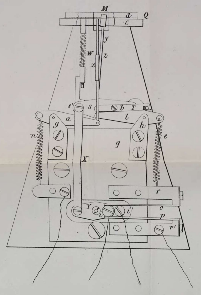

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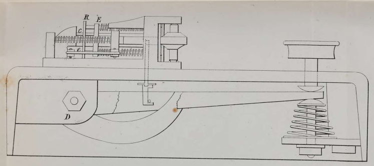

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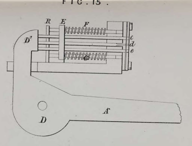

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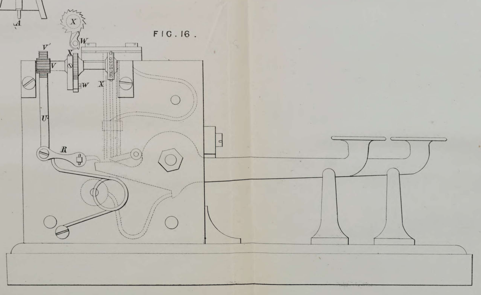

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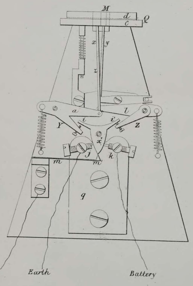

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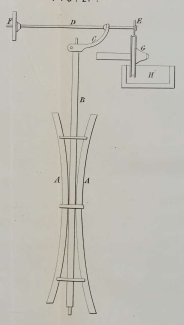

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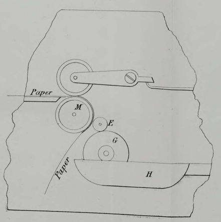

The filed drawing is not colored.

Drawn on Stone by Malby & Sons.

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